

This action is in response to Amendment C, paper #10, filed 11/21/02.

## DETAILED ACTION

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### ***Claim Rejections - 35 USC § 103***

1. The following is a quotation of 35 U.S.C. 103(a) which forms the basis for all obviousness rejections set forth in this Office action:

(a) A patent may not be obtained though the invention is not identically disclosed or described as set forth in section 102 of this title, if the differences between the subject matter sought to be patented and the prior art are such that the subject matter as a whole would have been obvious at the time the invention was made to a person having ordinary skill in the art to which said subject matter pertains. Patentability shall not be negated by the manner in which the invention was made.

2. Claims 6-10, 14-16, 19-21, 48-50, 51-53, 55, 57-61, and 63-64 are rejected under 35 U.S.C. 103(a) as being unpatentable over Wolf in view of Ding (US 5,814,563) and JP 200-349071.

Wolf teaches all of the positive steps of claims 6-10, 14-16, 19-21, 48-50, 51-53, 55, 57-61, and 63-64 except for the use of ammonia as the source of hydrogen and various and multiple fluorocarbons, hydrocarbons, chlorofluorocarbons and chlorohydrocarbons, the fluorocarbons consisting of one of C4F6 and C5F8 and the volumetric ratio of all fluorocarbons to ammonia being from 40:1 to 9:1.

Wolf (page 40 volume 2 teaches etching a trench in a semiconductor by etching through a patterned mask of pad oxide, nitride layer and photoresist, and into the silicon

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substrate. Wolf also teaches (pages 555-557 volume 1) anisotropic plasma etching through the mask and into the substrate using a dry etch of CF<sub>4</sub> gas and that the shape of the trench (result of etch selectivity) can be altered by adjusting the fluorine-to-carbon ratio with hydrogen additions and altering the etch chemistry to make the etchant more selective toward the photoresist. Wolf teaches the chlorofluorine gas for etching nitride, silicon oxide, and silicon. Wolf (pages 52-54) teaches etching a trench in a bulk semiconductor using fluorocarbons, the mask openings to form a plurality of trench isolations.

Ding teaches etching silicon oxide using fluorohydrocarbon gasses in an etching chemistry containing ammonia (NH<sub>3</sub>, a source of hydrogen, abstract) and in a magnetic field (magnetically enhanced plasma etching column 5 lines 13-15), the preferred volumetric ratio of fluorohydrocarbon to ammonia is 2.5: to 7:1 (column 2 line 57) which encompasses limitations of 40:1 to 3:1. Ding's figure 3 also shows that volumetric ratios of 10+:1 were also used, thus encompassing the limitations of "no less than 9:1. Ding also teaches using a combination of two fluorocarbons (column 9 line 65-column 10 line 4) and (plural, at least two, column 6 lines 7, "mixtures thereof" suggesting three,). Ding (column 5 lines 45-550 teaches that the etching chemistry comprises fluorocarbon gasses, NH<sub>3</sub> generating gas (ammonia), a carbon-oxygen gas, and an optional inert gas, thus teaching a chemistry which is essentially fluorocarbon gasses and ammonia. Further, (column 9 lines 17-18) Ding teaches that the flow rate of carbon-oxygen is

lower than that of the fluorocarbon, thus the combination of fluorocarbon and ammonia is greater than 50% of the mix, hence essentially fluorocarbon gasses and ammonia.

As Ding teaches volumetric ratios of 2.5 to 1 and graphs 10+:1 and suggests altering the ratio for different profile etches, and the instant application teaches ratios of 40:1 to 2:1, more preferably 40:1 to 3:1, and even more preferably 40:1 to 4:1, and further preferably no less than 6:1 and more preferably no less than 9:1 (all anticipated by Ding), and on page 8 "further preferably at least 20:1, the limitations in the claims are both anticipated by Ding and considered mere optimization. As taught by the instant specification, the ranges taught by Ding will work in the instant invention. These ranges are considered to involve routine optimization while it has been held to be within the level of ordinary skill in the art. As noted in *re Aller*, the selection of reaction parameters such as temperature and concentration would have been obvious:

"Normally, it is to be expected that a change in temperature, or in concentration, or in both, would be an unpatentable modification. Under some circumstances, however, changes such as these may impart patentability to a process if the particular ranges claimed produce a new and unexpected result which is different in kind and not merely degree from the results of the prior art. Such ranges are termed "critical ranges and the applicant has the burden of proving such criticality.... More particularly, where the general conditions of a claim are disclosed in the prior art, it is not inventive to discover the optimum or workable ranges by routine experimentation."

*In re Aller* 105 USPQ233, 255 (CCPA 1955). See also *In re Waite* 77 USPQ 586 (CCPA 1948); *In re Scherl* 70 USPQ 204 (CCPA 1946); *In re Irmscher* 66 USPQ 314 (CCPA 1945); *In re Norman* 66 USPQ 308 (CCPA 1945); *In re Swenson* 56 USPQ 372 (CCPA 1942); *In re Sola* 25 USPQ 433 (CCPA 1935); *In re Dreyfus* 24 USPQ 52 (CCPA 1934).

One skilled in the requisite art at the time of the invention would have used any ranges or exact figures suitable to the method in the process of etching regarding rate flows

and concentrations using prior knowledge, experimentation, and observation with the apparatus used in order to optimize the process and produce the etch profile structure desired to the parameters desired.

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The instant application teaches that the gasses can be introduced into the chamber either simultaneously or successively. As there is no teaching as to unexpected results of one method to another, there is no criticality between the two. Ding does not teach whether the gasses are introduced simultaneously or successively, but it is obvious that the method chosen must be one of the two. The examples only teach that the gasses are present.

It has been held that “[v]arying the details of a process, as by adding a step or splitting one step into two does not avoid infringement, where the processes are substantially identical or equivalent in terms of function, manner, and result. Universal Oil Products Co. v. Globe Oil and Refining Co., 322 U.S. 471, 61 USPQ 382 (1944); Ace Patents Corporation v. Exhibit Supply Co., 119 F.2d 349, 48 USPQ 667 (7th Cir. 1941); King-Seeley Thermos Co. v. Refrigerated Dispensers Inc., 354 F.2d 533, 148 USPQ 114 (10th Cir. 1965). Identity of the apparatus used for executing the processes is not material in itself. National Lead Company v. Western Lead Products Co., 324 F.2d 539, 139 USPQ 324 (9th Cir. 1963).” Excerpt from Matherson-Selig Co. v. Carl Gorr Color Card, Inc., 154 USPQ 265 (DC NIII 1967).

JP 2000-349071 teaches an apparatus for etching silicon, photoresists, and silicon nitride films using either CF<sub>4</sub>, CF<sub>4</sub> and C<sub>5</sub>F<sub>8</sub>, or C<sub>5</sub>F<sub>8</sub>, with a nitrogen source (commonly ammonia) and with or without CO<sub>2</sub> gas. The use of C<sub>5</sub>F<sub>8</sub> is preferred do to improved environmental results. Thus, using these fluorocarbons is well known in the art for etching these layers. Thus, using these fluorocarbons is well known in the art for etching these layers. The selection of a known material based on its suitability for its

intended use supported a prime facie obviousness determination in Sinclair and Carroll, Inc. v. Interchemical Corp., 325 U.S. 327, 65 USPQ 297 (1945 "Reading a list and selecting a known compound to meet known requirements is no more ingenious than selecting the last piece to put in the last opening in a jig-saw puzzle." 65 USPQ at 301).

One skilled in the requisite art at the time of the invention would modify Ding and Wolf by including multiple fluorocarbons in conjunction with ammonia as a hydrogen source and specifically C5F8 as taught by JP 2000-349071 to reduce environmental concerns, with reasonable expectation of producing a trench with better control of the etch profile angle (Ding column 1 line 55, Wolf page 552).

3. Claims 47 and 54 are rejected under 35 U.S.C. 103(a) as being unpatentable over Wolf in view of Ding (US 5,814,563) and JP 200-349071 as applied to claims 16 and 20 above, and further in view of Lucent Technologies.

Wolf and Ding teach all of the positive steps of claims 47 and 54 as recited above except for the use of a 193-nanometer photoresist. Ding (priority date 1996) uses a photoresist and gives as an example, a Riston photoresist. The release by Lucent Technologies (4/1997) announce a 193 nanometer photoresist for use in smaller and smaller designs in microelectronics (paragraph 3). As the trend in semiconductors is to decrease device size and increase density, it is obvious that one skilled in the art would alter a process to encompass new, known equipment for decreasing device size and increasing device density.

One skilled in the requisite art at the time of the invention would modify Ding by using a newer photoresist developed by Lucent Technologies with reasonable expectation of producing a pattern on a semiconductor with smaller device dimensions.

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***Response to Arguments***

4. Applicant's arguments filed 11/21/02 have been fully considered but they are not persuasive.

The applicant argues that none of the references used in the rejection of the claims teach a volumetric ratio of all fluorocarbon to ammonia from 40:1 to 20:1. However, the specification teaches ratios of 40:1 to 2:1, more preferably 40:1 to 3:1, and even more preferably 40:1 to 4:1, and further preferably no less than 6:1 and more preferably no less than 9:1, and on page 8 "further preferably at least 20:1. As Ding teaches ratios of 2.5:1 to 7:1, Ding teaches ratios that the instant specification teaches within the range of working ratios. Therefore, the range is one of optimization.

The applicant further argues that Wolf does not teach (etching) selectivity toward the photoresist can be changed by adjusting the etch chemistry to make it more selective toward the photoresist. The examiner never stated this. Rather, Wolf teaches that altering the fluorine to carbon ratio, the shape of the trench can be altered. But, figure 14 on page 555 shows decreasing the fluorine to carbon ratio alters the etched shape

and made the etchant more selective toward the photoresist than shown in the figure with a higher fluorine to carbon ratio. Clearly, Wolf is showing that in addition to altering the trench shape, altering the fluorine to carbon ratio will make the etchant more selective toward the photoresist.

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The applicant also argues that Ding teaches a processing gas with: i (fluorocarbon), ii (ammonia), iii (carbon-oxygen gas), and iv (inert) components and that only the iv component is optional. Therefore, Ding does not teach a etch gas that is essentially fluorocarbon and ammonia. But, as Ding teaches the flow rate of the carbon-oxygen gas is lower than that of the fluorocarbon gas, the carbon-oxygen gas is less than 50% of the mix, making the total mix essentially fluorocarbon and ammonia.

The applicant also argues that claim 20 limits the invention to an etch chemistry including ammonia and at least one of C4F6 and C5F8 and JP'071 uses the chemistry to etch both the photoresist and the silicon nitride. Although JP'071 does teach or suggest that these etchants be altered in fluorocarbon to ammonia ratio to selectively etch the photoresist as Ding teaches this for fluorocarbons. JP'071 was used to show that C4F6 and C5F8 are known etchants for photoresists and silicon nitride and silicon. Thus, using these fluorocarbons is well known in the art for etching these layers. The selection of a known material based on its suitability for its intended use supported a prime facie obviousness determination in Sinclair and Carroll., Inc. v. Interchemical Corp., 325 U.S. 327, 65 USPQ 297 (1945 "Reading a list and selecting a known

compound to meet known requirements is no more ingenious than selecting the last piece to put in the last opening in a jig-saw puzzle." 65 USPQ at 301).

### ***Conclusion***

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5. **THIS ACTION IS MADE FINAL.** Applicant is reminded of the extension of time policy as set forth in 37 CFR 1.136(a).

A shortened statutory period for reply to this final action is set to expire THREE MONTHS from the mailing date of this action. In the event a first reply is filed within TWO MONTHS of the mailing date of this final action and the advisory action is not mailed until after the end of the THREE-MONTH shortened statutory period, then the shortened statutory period will expire on the date the advisory action is mailed, and any extension fee pursuant to 37 CFR 1.136(a) will be calculated from the mailing date of the advisory action. In no event, however, will the statutory period for reply expire later than SIX MONTHS from the mailing date of this final action.

6. Any inquiry concerning this communication or earlier communications from the examiner should be directed to David S. Blum whose telephone number is (703)-306-9168 and e-mail address is David.blum@USPTO.gov.

If attempts to reach the examiner by telephone are unsuccessful, the examiner's supervisor, Carl Whitehead Jr., can be reached at (703)-308-4940. Our facsimile number for Before-Final Communications is (703)- 872-9318 and for After-Final

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Communications is (703)- 872-9319. The facsimile number for customer service is (703)-872-9317. Our receptionist's number is (703)-308-0956.

David S. Blum

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January 2, 2003